GLOBAL SCIAMACHY CLOUD PRODUCTS

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ABSTRACT

The Scanning Imaging Absorption Spectrometer for Atmospheric CHartographY (SCIAMACHY) measures the nadir top-of-atmosphere reflectance in the spectral range 0.24-2.4 μm with a high spectral resolution (0.2-0.5nm for most of channels) and is capable to provide information on the vertical columns and profiles of trace gases. In addition, global aerosol and cloud characteristics such as, e.g., the aerosol scale height, the cloud top height, the cloud thermodynamic state, the cloud fraction and the aerosol and cloud optical thickness can be derived. Currently, there are several cloud retrieval algorithms for SCIAMACHY based on different radiative transfer models. The task of this work is to present the results of the cloud retrievals using the Semi-Analytical CloUd Retrieval Algorithm (SACURA)(Kokhanovsky et al., 2003, 2005; Rozanov and Kokhanovsky, 2004). SACURA is incorporated in the SCIAMACHY operational processing chain (von Bargen et al., 2006). The results of global cloud retrievals for year 2006 are discussed.

1. INTRODUCTION

The operational data processor for SCIAMACHY (Bovensmann et al., 1999) on board ENVISAT was subject to major revisions as described by von Bargen et al.(2006). In particular, the semi-analytical cloud retrieval algorithm SACURA has been introduced in the operational retrieval scheme. The algorithm is based on asymptotic radiative transfer theory valid for thick clouds having optical thickness larger than five. The cloud optical thickness (COT) and cloud spherical albedo are determined from the top-of-atmosphere (TOA) reflectance at the wavelength 443nm and the cloud top height(CTH) is derived from the spectral TOA reflectance R in the oxygen A-band centered at 760nm (the 758-778nm wavelength range is used). The physical background of the retrieval is based on the fact that the cloud reflectance outside gaseous and condensed matter absorption bands is determined almost exclusively by COT (with small influences due to the size of particles) and that inside of gaseous bands R depends in addition on CTH and also on the cloud geometrical thickness (CGT). CGT is assessed in the framework of the retrieval procedure. Further details of the algorithm are described by Kokhanovsky et al. (2003) and also by Rozanov and Kokhanovsky (2004).

The aim of this paper is to present our recent results with respect to the derivation of global cloud characteristics as seen by SCIAMACHY from space for year 2006. Also results of intercomparisons of the MEdium Resolution Imaging Specrometer (MERIS) also onboard ENVISAT and SCIMACHY Processor 6 TOA reflectances are shown.

2. INTERCOMPARISON OF SCIAMACHY AND MERIS TOA REFLECTANCES

The SCIAMACHY Processor 5 data had calibration problems. Therefore, the new SCIAMACHY Processor 6 was introduced and the improved re-calibrated data have been delivered to the users. It is of importance to check the quality of the new data sets. With this in mind, we have compared TOA MERIS and SCIAMACHY reflectances. The intercomparison of MERIS and SCIAMACHY reflectances over ocean and cloud fields close to the coast of UK were performed by Kokhanovsky et al. (2007). It was found that Processor 6 SCIAMACHY reflectances coincide with those of MERIS in the spectral range 443-865nm within the MERIS calibration error, which is estimated to be equal to 4 percent. The aim of this study is to check how sensitive the results are to the underlying surface type. Also in addition to the previous study, the results at the wavelengths 490 and 510nm are reported. The intercomparisons for the SCIAMACHY Processor 6 orbit 22321 (June 7, 2006) have been performed. The orbit includes ice, ocean, cloud fields, and different land underlying surfaces. The results of intercomparisons are shown in Fig.1. We found that the ratio of SCIAMACHY to MERIS reflectances is close to one. The difference is smaller than 3 percent. Therefore, we conclude that SCIAMACHY Processor 6 calibration error is inside that of MERIS in the spectral range 443-865nm. This confirms our findings reported for a smaller dataset earlier(Kokhanovsky et al., 2007) and enables the determination of accurate cloud products (e.g., COT and CTH) from SCIAMACHY TOA measurements.

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3. CLOUD PRODUCTS

The SACURA cloud products are derived using measurements at the wavelength 443nm(COT) and 758-778nm (CTH). The SCIAMACHY TOA reflectance for year 2006 is given in Fig.2 (upper panel). Namely this spatial distribution of reflectance determines the spatial distribution of COT shown in the middle panel of Fig.2. The increased reflectance and also cloud optical thickness is found in the tropics, north of Antarctic and also in the Pacific in the region south-east of China. The increased reflectivity around Beijing is the mark of increased industrial activity in this country (e.g., the production of aerosols and suppression of precipitation). The green colour at the northern latitudes on the upper panel is mostly due to the snow cover existing in the correspondent areas in winter months.

The cloud top height spatial distribution for year 2006 is shown in Fig.2 (lower panel). High clouds are marked by the yellow colour. They exist in the tropical belt. Also the three oceanic deserts (blue colour) are clearly seen on the map to the east of South America, Africa, and Australia. These areas are related to the cold water arriving from the shores of Antarctic. This reduces the evaporation and the formation of water vapour and also clouds. Overall, general patterns revealed by SACURA are consistent with the previous understanding of the distribution of the global cloudiness over the globe. However, the further validation of retrievals is needed. Some of SACURA validation studies are reported by Kokhanovsky et al. (2004, 2006) and Rozanov et al. (2004).

4. CONCLUSIONS

The results of global retrievals of COT and CTH using SCIAMACHY measurements are presented. Also SCIAMACHY TOA reflectances are compared with those of MERIS.

The technique as used by SACURA to retrieve COT is based on the studies of the cloud reflectance. Many other instruments use the similar technique to retrieve COT. Some of them provide superior information as compared to SCIMACHY. This is due to the comparatively large ground scene of SCIAMACHY ($30km * 60km$) and the often presence of broken cloud fields in the field of view of the instrument. On the other hand, hyperspectral oxygen A-band measurements of SCIAMACHY are unique. This enables the accurate determination of the cloud top height using the technique completely different from that usually applied for the cloud top height determination (thermal infrared measurements). At the moment we are in the process of comparisons of cloud top height derived using these diverse remote sensing methods.

The SACURA cloud products (e.g., cloud optical thickness, cloud spherical albedo, and cloud top height) are used in the SCIAMACHY trace gas retrievals schemes (von Bargen et al., 2006).

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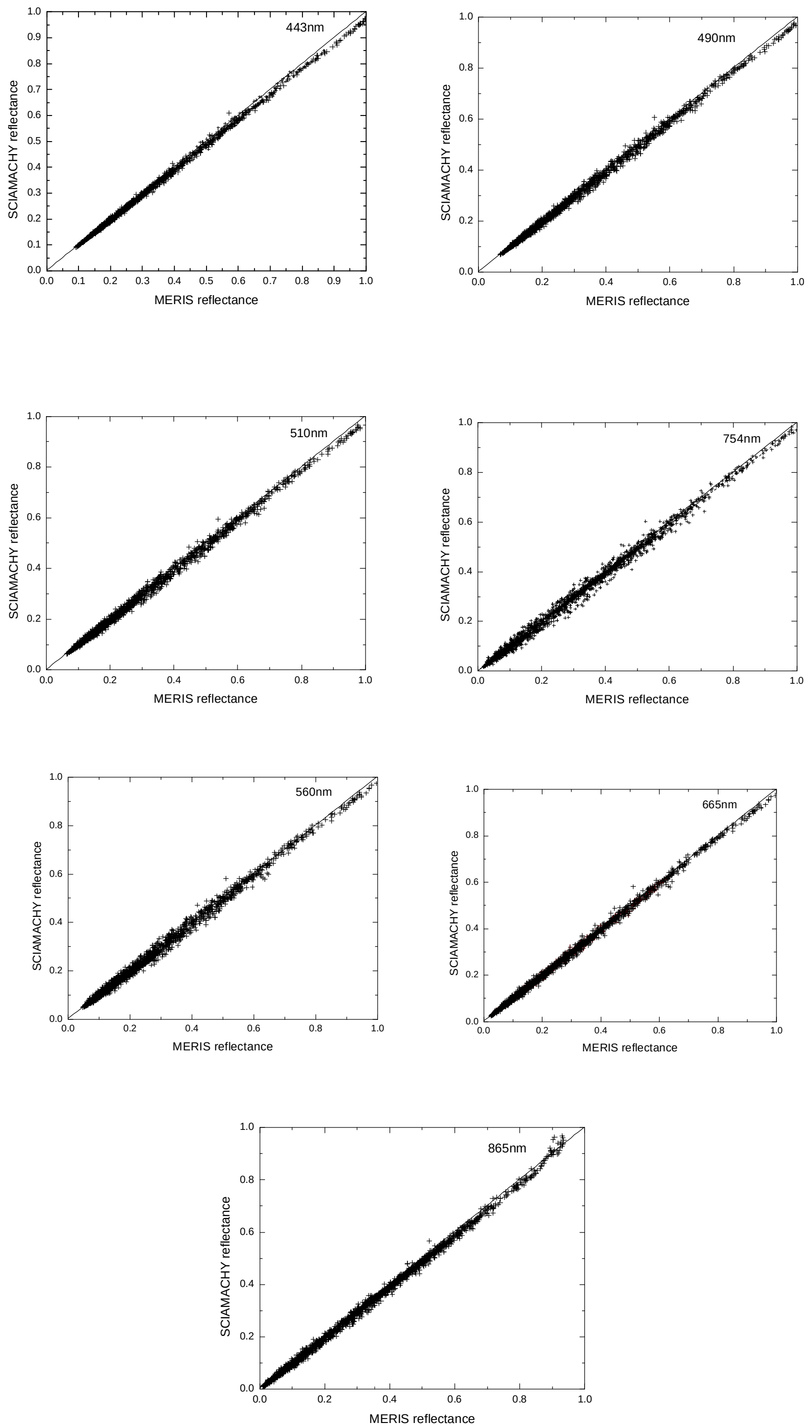

Figure 1. The intercomparison of SCIAMACHY and MERIS TOA reflectances.

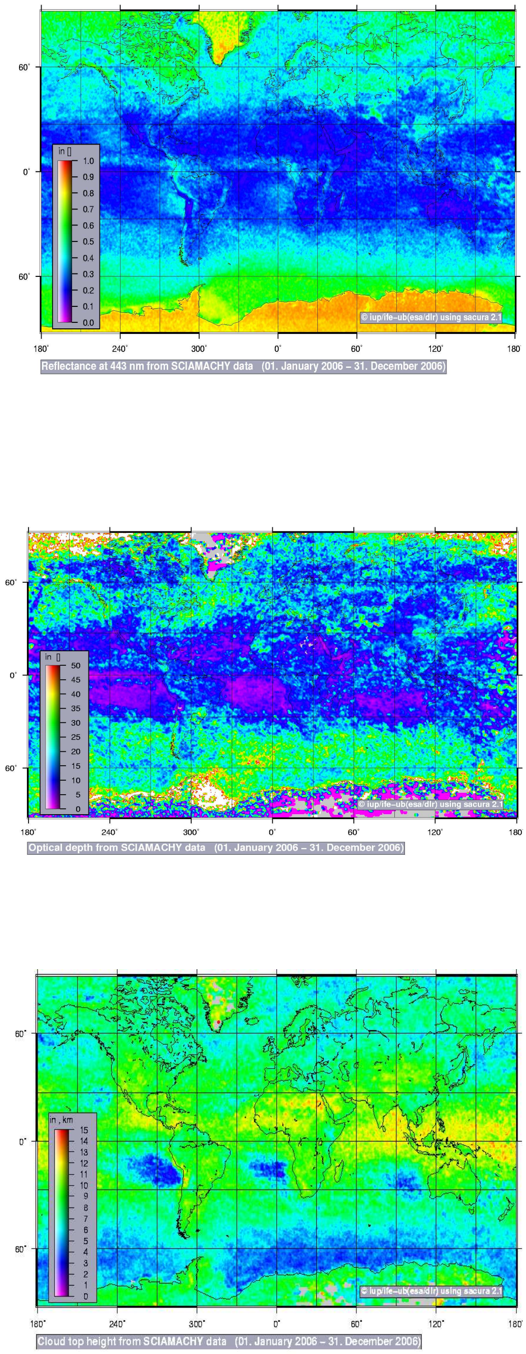

Figure 2. The TOA reflectivity at 443nm as measured by SCIAMACHY for year 2006(upper panel). The cloud optical thickness spatial distribution for year 2006 (middle panel). The cloud top height spatial distribution for year 2006 (lower panel)